Annual Report to

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Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US

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Overview of activities this period

A summary of progress on the project plan are provided below and discussed on the following page:

Project Activity	2006 Q2	Q3	Q4	2007 Q1	Q2	Q3	Q4	2008 Q1	Q2	Q3	Q4	2009 Q1	Q2	Q3	Q4	2010 Q1	Q2	Q3	Q4	2011 Q1
project period	■	■	■	■	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
funding received	■	■	■	■																
RLTM outlets				▫				░				░				░				░
RLTM drainage lakes		■	■		░	░	░	░		░	░	░	░	░		░	░	░		
RLTM seepage lakes		■	■		░	░	░	░		░	░	░	░	░		░	░	░		
original LTM lakes			■				░			░				░				░		
HELM subset			■				░													
BBWM - EB	■	■	■	■	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
TIME lakes		■				░		░			░		░			░			░	
sample analyses		■	■	■		░		░		░		░		░		░		░		░
zooplankton analyses			░	▨		░		░												
progress report				■				░								░				░
annual data report	■				▨															

░ = project plan   ▨ = in progress   ■ = completed   ▫ = activity cancelled

Field sampling. Field sampling for all main project components recommenced in the summer of 2006 upon receipt of funding in late spring. All project field objectives in the summer and fall of 2006 were accomplished as planned. Data collection had continued despite the project being in non-cost extension during 2004 and 2005. Spring sampling for all lakes in Maine will commence in April.

Analytical. Analyses are complete for all samples collected through the end of 2006, except for aluminum which has an extended holding time. PSU has ordered an AAS HGA instrument for analysis of Al, due to the last minute closure of the laboratory at UMaine that previously served this project. Inter-laboratory comparisons were completed between PSU, UNH, and UMaine (prior to closure of the Mitchell Center laboratory).

Samples from East Bear Brook at BBWM, which are collected on a regular basis year around, are being analyzed in a contract laboratory at UMaine. It is not yet known if this laboratory will be able meet EPA DQOs or if they will provide an annual QA report.

Zooplankton analyses. Samples from 1986 have been archived and checked. A small number of sample bottles had broken or leaked. We have gained access to a FlowCam (Fluid Imaging, Inc.) for sizing the zooplankton and received training from staff at the EPA laboratory in Chelmsford who are using a similar instrument to analyze their zooplankton samples. This would save significant time in processing samples. We plan to run the 1986 and 2004 size spectra and cladoceran species analyses over the spring and summer. The EPA lab in Chelmsford has also made arrangements for a permanent archiving of the zooplankton samples at Yale University.

Data reporting. All data collected through 2004 have been delivered to EPA. The next delivery of data to EPA is expected to be done in late spring, after evaluation of inter-laboratory comparisons.

Presentation of findings. Several publications have resulted from this project since the final report for the previous LTM/TIME grant. Several presentations have also been made to a variety of audiences, including a talk invited by EPA OAR at the 2005 ESA annual meeting, and a talk invited by EPA OAR at the 2006 international mercury meeting that developed recommendations for national Hg monitoring based on the success of TIME/LTM. Publications and talks are listed at the end of this report.

Project status: We have requested funding for field season 2007, and are aware that there is uncertainty for funding in FY08. Therefore, we are planning to not sample the outlets of drainage lakes in the spring of 2007 to facilitate the option of stretching the funding out into 2008 for baseflow sampling for RLTM lakes and summer sampling for TIME lakes. The outlet work is expensive and difficult, and we believe that this option provides for more cost-effective use of funds under the present uncertain scenario.

Project overview

<u>Objectives</u>. This proposed research is part of the EPA program to collect long-term data on the trends and patterns of response in surface waters sensitive to acidic deposition.   The goals and methods are hierarchical from intensive site-specific to statistical regional statistical populations. The objectives are to:

1) document the changes and patterns in aquatic chemistry for defined sub-populations and sites that are known to be susceptible to acidification or recovery,
2) evaluate linkages in changes in surface waters, if any, to changes in deposition that are related to regulatory goals;
3) characterize the effectiveness of the Clean Air Act Amendments in meeting goals of reducing acidification of surface waters and improving biologically-relevant chemistry in the northeastern US, and
4) provide information for assessment of the need for future reductions in atmospheric deposition based on the rate of recovery (or not) of the systems under study.

In 2007, we will also evaluate changes in biological condition using zooplankton collected in 2004 from 145 ELS-II lakes in the northeast, as part of our 20th anniversary re-analysis of the Eastern Lake Survey.

<u>Approach</u>. The schedule of tasks ranges from weekly to annual, continuing data records that range from 12 to 22 years. We will evaluate chemistry on a weekly basis year-round at the small watershed-scale at BBWM, weekly during the spring melt period at LTM lakes outlets, quarterly in LTM, and during an annual index period for the HELM and TIME lakes.   These project components provide a *statistical framework* for inferring regional chemical patterns using TIME and LTM (and ELS-II under separate funding). The *long-term records* of LTM, HELM and BBWM provide seasonal and annual variability information, and provide seasonal context for the annual surveys.

<u>Expected Results</u>. This information is fundamental for EPA to meet the Congressional mandate for reporting on the effectiveness of the Clean Air Act Amendments (CAAA). The highly effective combination of site-specific data within the regional context will provide for the recognition and understanding of declining SO_4, base cation depletion, and changes in N-saturation or DOC contributions to acid-base status.   The results are also central to the decisions on additional emission reductions that may be needed to produce recovery.

Recent publications using project information

Campbell, J, J. Hornbeck, M. Mitchell, M. Adams, M. Castro, C. Driscoll, J.S. Kahl, and others, 2004. Input-output budgets for inorganic nitrogen for 24 watersheds in the northeastern United States. Water Air Soil Pollut., 151:373-396.

Dupont, J., T. Clair, C. Gagnon, D. Jeffries, J.S. Kahl, S. Nelson, and J Peckenham, 2005. Estimation of critical loads of acidity in the northeastern US and eastern Canada. Environ. Monit. Assess. 109:275-291.

Hunt, K., J.S. Kahl, J. Rubin, and D. Mageean, 2007. Assessing the science-based needs of stakeholders; a case study on acid rain research and policy. Journal of Contemporary Water Research and Education, in press.

Kahl, J.S., J. Stoddard, R. Haeuber, S. Paulsen, R. Birnbaum, F. Deviney, D. DeWalle, C. Driscoll, A. Herlihy, J. Kellogg, P. Murdoch, K. Roy, W. Sharpe, S. Urquhart, R. Webb, and K. Webster, 2004. Response of surface water chemistry to changes in acidic deposition: implications for future amendments to Clean Air Act. Environmental Science and Technology, Feature Article 38:484A-490A.

Lawler, J., J. Rubin, B.J. Cosby, I. Fernandez, J.S. Kahl, S. Norton, 2005. Predicting recovery from acidic deposition: Applying a modified TAF (Tracking Analysis Framework) Model to Maine' High Elevation Lakes, Water Air Soil Pollut. 164:383-389.

Norton, S., I. Fernandez, J.S. Kahl, and R. Reinhardt, 2004. Acidification trends and the evolution of neutralization mechanisms through time at the Bear Brook Watershed, Maine, USA. Water, Air, Soil, Pollution Focus 4:289-310.

Rosfjord, C., K. Webster, J.S. Kahl, S.A. Norton, I. Fernandez, and A. Herlihy, 2007. Anthropogenically-driven changes in chloride complicate interpretation of base cation trends in lakes recovering from acidic deposition. Environmental Science and Technology, in press.

Recent presentations using project information

Kahl, J.S. 2006 (invited). Acid rain in New England: using high elevation lakes as sentinels of change. Maine Mountain Conference, October 21, 2006. Rangeley, Maine

Kahl, J.S., *et al*., 2006 (invited). The design of a national mercury monitoring network: Learning from the EPA acid rain experience. The Eighth International Mercury Conference, Madison WI, August 8, 2006.

Kahl, J.S. *et al*., 2006. Obfuscation of trends in base cations by regional salt contamination. Hubbard Brook Committee of Scientists annual meeting, July 12, 2006.

Kahl, J.S., 2006 (invited). 'Natural and human-derived sources of acidity in Maine Atlantic Salmon Rivers'. Atlantic Salmon Commission workshop on acidity, Bangor ME. April 10, 2006.

Kahl, J.S., 2005 (invited). The intersection of environmental science and environmental policy. NH Charitable Foundation Lakes Region annual meeting, Meredith, NH, September, 2005.

Kahl, J.S., 2005 (invited). Tracking response and recovery in surface waters in the northeastern US. Annual meeting of the Ecological Society of America, Montreal, August, 2005.

Kahl, J.S., and Catherine Rosfjord, 2005 (invited). Acid rain and the Clean Air Act in the northeastern US. Annual meeting of the NH-ME Androscoggin River Watershed Council, Bethel, June, 2005

Kahl, J.S., 2005 (invited). Developing a lake research agenda for NH. NSF workshop on lake research infrastructure in the northeast, Colby Sawyer College, April 2005.

Kahl, J.S., S. Nelson, and A. Grygo, 2004. Surface water chemistry data for the northeastern US for interpreting climate and acid rain trends. Northeast Ecosystems Research Consortium meeting, Durham, NH, October, 2004.

Kahl, J.S., K. Webster, M. Diehl, and C. Rosfjord, 2004. Successes of the Clean Air Act Amendments of 1990. Maine Water Conference invited plenary talk, Augusta, ME, 2004.

Kahl, J.S. and K. Johnson, 2004. Acid-Base Chemistry and Historical Trends in Downeast Salmon Rivers. Maine Water Conference, Augusta ME, April 2004.

Kahl, J.S., 2004 (invited). The Clean Air Act Amendments of 1990; testing a program designed to evaluate environmental policy. Lecture, Colby College. April, 2004